

which had been productive with the female of *E. roratus*, and got the following results :—

1888. First deposit, 2 embryos.
Second deposit, 2 embryos.
Third deposit, 2 unimpregnated eggs.
Fourth deposit, 2 *young birds*, which died after one or two days.
Fifth deposit, 1 *green male* (which was reared) and 1 embryo.
1889. First deposit, 2 embryos.
Second deposit, 2 unimpregnated eggs.
Third deposit, 2 unimpregnated eggs.

Therefore from all these deposits of eggs only two females and seven males have been reared and of these only four males are still living. The sex of these four males is only determined by the colour of the plumage, a character, however, which appears to be entirely trustworthy. As Mr. Hieronymus has placed nineteen of the embryos in my hands, ten of which are in pairs, I may, perhaps, still succeed by microscopical investigation in determining the sexes, and thus ascertain whether the male sex prevails or not, and whether a pair among them does not sometimes consist of male and female.

IV.—*An Attempt to Diagnose the Pico-Passerine Group of Birds and the Suborders of which it consists.* By HENRY SEEBOHM, F.Z.S.

IN my investigations into the osteology of the Grallo-Galline and Ardeo-Anserine group of birds (Ibis, 1888, p. 415, and 1889, p. 92) I have found that however constant a character might be in one or more groups, there were almost sure to be other groups in which it broke down. In investigating the large group of birds consisting of the Passeres and the Picariæ, it seems as if osteological characters ceased to be entirely reliable, and required the assistance of other characters to make the diagnoses of the subdivisions complete.

It appears to be impossible to construct a diagnosis of the Passeres founded solely on osteological characters. All the Passeres are ægithognathous, but other birds, obviously not Passerine, are also ægithognathous. Most of the Passeres have only one notch on each side of the posterior margin of the sternum; but some Passeres have two, and many birds not at all Passerine have only one. In most Passeres the outer episternal process or manubrium is well developed and forked, but in some Passeres it is not forked, and in some birds not Passerine it is forked. It seems therefore to be necessary to call in some other characters, not osteological, to complete the diagnosis.

The deep plantar tendons are the muscles which, when contracted, close the foot, and enable the bird to grasp its perch or seize its prey. The different ways in which these plantars are arranged afford characters which appear to be of some value in the classification of birds. They run down the back of the tarsus, sometimes side by side, but generally crossing each other about the middle of that bone. The inner and, when they cross, always the front plantar, is named the *flexor perforans digitorum*; the outer and, when they cross, always the hind plantar, is named the *flexor longus hallucis*; but for the sake of brevity we may call the former the front plantar, because it generally moves the front toes, and the latter the hind plantar, because it generally closes the hind toe. The most common arrangement of the plantars is that found in the Common Fowl, and may therefore be called the Galline arrangement. In this bird, when the front plantar reaches the base of the tarsus it splits into three tendons, one of which leads to each of the three front toes. The hind plantar leads to the hind toe, but where it crosses the front plantar it sends down a branch (called the *vinculum*) to the front plantar, apparently to utilize its superfluous strength, which would otherwise be wasted on so feeble an organ as the hind toe of the Common Fowl and other similarly formed birds. The size of the *vinculum* varies according to the feebleness of the hallux. Where the hallux is absent or very small the *vinculum* absorbs the whole of

the hind plantar (or nearly so); but where the hallux is much used (as in the Herons) the vinculum becomes very small, and disappears altogether in the Bittern and in most of the Passeres. The Passerine arrangement of the plantars thus intergrades with the Galline arrangement, of which it may be regarded as a modification. Two other slight modifications of this arrangement appear in some of the Falconidæ.

In comparison with the Galline arrangement of the plantars and its modifications, the Picine arrangement appears to be quite distinct. It only occurs in zygodactyle birds, but not in all of them. In the typical Picine arrangement the front plantar leads to the outer front (or 3rd) toe only, the hind plantar dividing into three, to lead to the two hind (the 1st and 4th) and the inner front (or 2nd) toes. A slightly modified form of this arrangement occurs in the Trogonidæ, where the front plantar leads to the two front toes (the 3rd and 4th), and the hind plantar to the two hind toes (the 1st and 2nd). In the Picine arrangement, whether typical or Trogonine, the front plantar does not lead to the second toe.

There remains yet a third arrangement of the deep plantar tendons, which differs from either of the other two, or from any of their modifications, to such an extent that it seems to denote, in the birds which possess it, that it has been derived by inheritance from a common ancestor, and has not been independently acquired by any of them. It also appears in two slightly differing forms, which have been unitedly called synpelmous. In synpelmous birds the plantars do not cross each other at the back of the tarsus (as in all other birds), but coalesce at the point where they usually cross. The peculiarity of this arrangement consists in the remarkable fact that the hallux is contracted by a tendon from the front plantar (instead of the hind plantar, as in all other birds), sent down, in the Caprimulgidæ and their allies *after*, and in the Alcedinæ and their allies *before*, its coalescence with the hind plantar, the coalesced plantars splitting into three to contract the three front toes. In the

Caprimulgine arrangement, whether typical or Alcedine, the hallux is contracted by the front plantar.

I therefore propose to associate the synpelmous Picariæ in an Order by themselves, and consequently to exclude them from the Pico-Passerres.

PICO-PASSERES.

The Pico-Passerres contain nearly half the species of existing birds, and are, on the whole, the most highly developed. In the arrangement of their palatine bones they are generally ægithognathous, but some of the more aberrant families contain species which are schizognathous, desmognathous, or saurognathous. Of the innumerable characters which they all possess the following appear to be specially valuable for their diagnosis:—

1. They have no ambiens muscle.

This character excludes all birds except the Podicipes, the Striges, the Alcidæ, the Syndactyli, and some of the Casuarii, the Psittaci, the Tubinares, the Columbæ, and the Herodiones.

2. The myological formula of the muscles of the thigh is AX or AXY (the accessory femoro-caudal is never present, whilst the femoro-caudal and the semitendinosus are never absent).

This character excludes the Casuarii, the Striges, the Podicipes, the Columbæ, and many other birds.

3. In their pterylosis the spinal feather-tract is never interrupted by a naked tract on the hind neck.

This character excludes the Herodiones.

4. In the arrangement of the deep plantars, the hallux is always in direct connection with the hind plantar.

This character excludes the synpelmous Picariæ, or Syndactyli.

5. The dorsal vertebræ are all heterocœlous.

This character excludes the Psittaci, the Gavio-Limicolæ (of which the Alcidæ are a family), and some other birds.

6. They have no supraorbital fossæ for the reception of the nasal glands.

This character excludes the Tubinares.

Each of these six characters appears in every Pico-Passerine bird ; each of them is also found in some bird which is not one of the Pico-Passerines ; but the combination of the six characters is never found in any bird which is outside the limits of the Pico-Passerines.

The order to which we have restricted the name Pico-Passerines may be easily divided into five suborders, which appear to be natural groups.

Passeres.

There has been some difference of opinion as to the exact boundaries of this group. If the Passeres be diagnosed as *ægithognathous birds, with a cæcum and a nude oil-gland*, the Eurylæmidæ will be admitted and the Upupidæ will be excluded. If they be diagnosed as birds with *free plantar tendons, and a spinal feather-tract uninterrupted between the crown and the upper back*, the Upupidæ will be admitted and the Eurylæmidæ excluded. If they be diagnosed as *ægithognathous birds with free plantars*, both the Eurylæmidæ and the Upupidæ will be excluded. The last-named diagnosis is so incomparably the best, the two characters accepted being so very much more exclusively Passerine than the two rejected, that it seems wisest to adopt it, with all its consequences. The Passeres may therefore be diagnosed as follows :—

1. They are ægithognathous.
2. The hind plantar is free from the front plantar.

The division of the Passeres into families is a complicated question, which must be deferred to a future paper.

Eurylæmi.

If the Broadbills be regarded as too aberrant a family to be admitted into the suborder Passeres, they must be allowed to constitute a suborder by themselves. They are unquestionably very nearly allied to the Passeres ; they possess cæca, the oil-gland is nude, and in their pterylosis they agree with *Hirundo* and other aberrant Passerine birds.

They have only one notch on each side of the posterior margin of the sternum, but their manubrium is not forked. Neither of these characters is, however, exclusively Passerine, or universally so. They are syndactyle, by no means a Passerine character. They are very easily diagnosed.

1. They are ægithognathous.
2. They have Galline plantars.
3. The oil-gland is nude.

It is necessary to add the last character in order to exclude the Turnicidæ and the Thinocoridæ, which possess the first two characters.

Upupæ.

The Upupæ (including the Irrisoridæ) differ from all existing birds in combining two characters.

1. The hind plantar is free from the front plantar.

This character excludes, so far as is known, all birds except a few of the Herodiones and most of the Passeres.

2. The feet of the coracoids are bridged over by the union of an outer with an inner episternal process.

This character excludes, so far as is known, all birds except the Meropidæ, the Bucerotidæ, the Gallinæ, and a genus of Cuculidæ.

The question is, which of these two characters is the oldest in the Upupæ? It seems to me to be most probable that the Passeres and the Herodiones have independently lost the vinculum which connected the front plantar with the hind plantar in the feet of their common ancestors, and that the Upupæ, like the Gallinæ, have acquired an episternal bridge, independently of the Meropidæ and the Bucerotidæ; whilst the extremely exceptional arrangement of the plantars in the synpelmous Picariæ has been inherited from a common ancestor. These conclusions, if sound, make it necessary to remove the Upupæ from the Picariæ to the Pico-Passeres, and to transfer the Cathartæ from the Raptores to the synpelmous Picariæ.

The Upupæ are Passerine in having the hallux very large and in having only one notch (or fenestra, as the case may

be) on each side of the posterior margin of the sternum. The arrangement of their plantar tendons is precisely the same as that of the Passeres. The fact that, like the Bucconidæ, the Galbulidæ, the Rhamphastidæ, and many of the Capitonidæ, they are desmognathous, cannot be regarded as of much importance ; but it must be admitted that they are not at all Passerine in their pterylosis. The spinal feather-tract has an interscapular fork, as in *Cypselus*, *Caprimulgus*, *Coracias*, &c. ; and the inferior tract is completely forked on each side of the breast, as in most of the Scansores. To find a combination similar to that of *Upupa*, it would probably be necessary to descend as low as the Gaviæ or Limicolæ.

Scansores.

The Scansores are a clearly defined group of birds, perhaps nearest allied to the Trogons, but having so many characters in common with the Upupæ, the Eurylæmi, and the Passeres, that they may be associated with them in an Order.

So far as is known, the Scansores are the only birds in which the front plantar (*flexor perforans digitorum*) leads only to the third digit (the middle toe of anisodactyle birds, or the outer front toe of zygodactyle birds). This character alone is therefore sufficient to diagnose the Scansores ; but the further character may be added that they are zygodactyle (*i. e.* the outer front toe, or fourth digit, is reversed, and becomes the outer hind toe). The latter character, however, is not confined to the Scansores, but is also found in the Pseudo-Scansores (Coccyges, Musophagi, Striges, and Psittaci), and to some extent in *Pandion* and *Leptosomus*.

In the arrangement of their palatal bones the Scansores vary in a remarkable manner. The Indicatoridæ resemble the Passeres in being ægithognathous ; the Capitonidæ are, some of them, ægithognathous and some desmognathous ; the Picidæ are schizognathous, but the split vomer and small maxillo-palatines are so peculiar that they have been called saurognathous ; whilst the Rhamphastidæ, Galbulidæ, and Bucconidæ are desmognathous.

The femoro-caudal and semitendinosus muscles are always present, but the ambiens and accessory femoro-caudal are always absent. The accessory semitendinosus is nearly always present, but is absent in some of the Picidæ.

The Galbulidæ and the Bucconidæ have cæca and a nude oil-gland. The Rhamphastidæ, the Capitonidæ, and the Indicatoridæ have no cæca and a tufted oil-gland. The Picidæ have also a tufted oil-gland, and the cæca are either absent or only rudimentary.

In the arrangement of their feather-tracts these families do not differ very much from each other. In none of them is there an interscapular fork to the spinal tract, as there is in *Upupa*; but in all of them there is a post-scapular bare spinal space, as in *Eurylæmus* and *Hirundo*. In the Indicatoridæ, the Galbulidæ, and the Bucconidæ the spinal tract passes between the scapulars and then divides into two branches, one of which passes on each side of this bare space; but in the Picidæ, the Rhamphastidæ, and the Capitonidæ this fork is omitted, and the spinal tract suddenly ends in a bare dorsal space. The arrangement of the feather-tracts on the rump varies, but that on the underparts is remarkably constant. There are two distinct feather-tracts on each side of the breast, coalescing on the shoulder (as in *Upupa*), except in the Galbulidæ, where they coalesce along the whole line. The Galbulidæ are also abnormal in having a transverse clavicular feather-tract on each side of the breast.

From these characters the suborder Scansores and the six families it contains may be diagnosed as follows:—

1. The fourth digit is reversed.
2. The front plantar leads to the third digit only.

The Scansores may be subdivided into two groups:—

A. Passerine Scansores, with cæca and with a nude oil-gland.

Bucconidæ: vomer absent; a clavicular feather-tract on each side of breast.

Galbulidæ: vomer present; no clavicular feather-tract on each side of breast.

B. Picine Scansores, without cæca and with a tufted oil-gland.

Picidæ: vomer slender, pointed, split; maxillo-palatines free.

Indicatoridæ: vomer bifid; maxillo-palatines free; spinal feather-tract surrounding a post-scapular naked space, but otherwise continuous.

Capitonidæ: vomer bifid; maxillo-palatines sometimes free, sometimes coalesced; spinal feather-tract interrupted by the absence of the anterior postscapular fork.

Rhamphastidæ: vomer truncated; maxillo-palatines coalesced.

+ *Heterodactyli*.

The Trogons are very curious birds. They agree with the Scansores and the Pseudo-Scansores in having two toes in front and two behind; but they differ from both those groups (and from all other birds) in having the second digit (the inner front toe of anisodactyle birds) reversed. In a heterodactyle bird the hallux is the outer of the two hind toes, whereas in a zygodactyle bird the hallux is the inner one. This perfectly unique arrangement of the toes is correlated with a perfectly unique arrangement of the deep plantar tendons. The front plantar leads to the two front toes, and the hind plantar to the two hind toes. This arrangement (apparently so simple and natural) is in strong contrast with those of the two zygodactyle groups. In the Scansores the front plantar leads to the third digit only, whilst in the Pseudo-Scansores the hind plantar leads to the first digit (the hallux) only.

In other respects the Trogons are also remarkable. They combine the cranial characters of *Caprimulgus* with the pterylosis of *Motacilla*, and the thigh-muscles and sternum of *Alcedo*. They are schizognathous and holorhinal; and they are the only birds in the Order of Pico-Passerines which permanently retain their basipterygoid processes.

The Heterodactyli consist of one family only, the Trogonidæ.